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DEVICE AND METHOD FOR DETERMINING AT LEAST ONE VARIABLE ASSOCIATED WITH THE ELECTROMAGNETIC RADIATION OF AN OBJECT BEING TESTED

The invention concerns devices and methods for the determination of at least one variable associated with the electromagnetic radiation from an object under test.

In order to determine the radiation diagram of an object under test, it has already been proposed that use should be made of devices that come in the form of a network of probes distributed in an arc around the object under test to be studied (a circular network).

We are familiar in particular with devices of this type that include means which allow the arc of probes and the object under test to rotate in relation to each other around an axis that corresponds to the diameter of the arc. In general, it is the object under test which rotates on itself around a vertical axis which corresponds to the diameter of the arc, but it can be envisaged, in a variant, that it is the arc of probes that rotates on itself, while the object under test remains fixed.

In this way, the network of probes measures the radiation of the object under test in successive planes spread around the axis of rotation of the arc and the object under test. In general then, the measurements are therefore taken on a sphere that totally surrounds the object under test.

We are also familiar with the use of networks of probes in an arc by moving, in a relative manner, the object under test perpendicularly in relation to the plane of the network of probes so as to measure the radiation on a cylinder enclosing the object.

The arrangement of a network of probes in a arc, whether used for measurements in spherical coordinates or measurements in cylindrical coordinates, nevertheless have limitations associated with the discrete measurement pitch imposed by the arrangement of the probes in a network.

In contrast to the case of a single probe which can be moved continuously, the use of a network of probes imposes constraints on the dimensions of the object under test, and whose field is to be measured.

In particular, according to theories that are well known in the near-field area, the number of sampling points is linked to the electrical dimension of the object under test.

Reference can be made in this regard to:

Hansen, J. E., Editor (1988) Spherical Near-Field Antenna Measurements, London: Peregrines

In particular, the number of sampling points is a function of the radius (R) of the minimum sphere or of the minimum cylinder surrounding the object under test and verifies:

$$N \approx (2\Pi R/\lambda) + n \text{ where } n \approx 10$$

As a consequence, it is understood that a network of N probes allows only the analysis of objects contained in a sphere or in a cylinder with a maximum radius R.

In other words, for a given analysis frequency or wavelength, and for a given network of probes, there exists a maximum size of objects capable of being analysed.

One aim of the invention is to circumvent this drawback, and to allow this constraint to be removed in order to broaden the area of use of a given network, in particular in terms of the size of the objet under test or the range of frequencies or wavelengths at which it is capable of being analysed.

This aim is achieved by the invention through a device for the determination of at least one characteristic of electromagnetic radiation from an object under test that includes a support intended to receive the said objet and a network of probes distributed over a more or less circular arc, characterised in that it includes means that allow the relative tilting** of the network of probes and of the support in the plane of the network of probes or parallel to the latter, so as to angularly shift the network of probes and the

support in relation to each other, and thus allow measurements to be taken in several relative angular positions of the network of probes and the object under test.

With such a device, it is possible to angularly shift the network of probes in relation to the support, while also supplying at least a second series of measurements. In this way, it is possible to multiply the number of points sampled in each plane, without increasing the hardware required.

The points obtained in the course of several successive series of measurements are then combined to form a denser mesh than that allowed by the circular network of probes.

Other characteristics, aims and advantages of the invention will appear on reading the detailed description that follows, which is purely illustrative and not limiting in any way, and which should be read with reference to the appended drawings in which:

- figure 1 is a diagrammatic representation of one possible mode of implementation of the invention;
- figure 2 is a diagrammatic representation of another possible mode of implementation of the invention.

Figure 1 shows an arc 10 that includes a multiplicity of electromagnetic probes or measuring antennae 11 represented diagrammatically by crosses, as well as a support 20 intended to carry the object for which one is seeking to ascertain the electromagnetic behaviour (a mobile telephone for example). This support 20 is essentially a mast which extends from the ground 30 to close to the geometric centre of the arc. This geometric centre is highlighted in figure 1 by a circle 40.

The arc 10 is fixed in relation to the ground, while the mast comprising the support 20 is driven in rotation around its main axis, which is referenced by A in figure 1.

Driving means 27 of the geared type are provided for this purpose at the base of the mast.

Means are also provided which allow the base of the mast 20 to be swinged, and latter to be slightly pivoted, therefore slightly pivoting the object under test around the centre 40.

This pivoting allows axis A to be displaced angularly in relation to the network of probes, and several positions to be swept relative to axis A and the object under test in relation to the network of probes.

Thus, for each measurement plane, that is for each position for which the mast 20 is fixed in its rotation around its axe 20, it is possible to take several consecutive readings that correspond to different relative angular displacements of the network of probes in relation to axis A and the object under test.

Tilting of the mast 20 in the plane of the arc is therefore used to multiply the electromagnetic measuring points around the object under test and to execute, with a network of probes of given pitch, a sampling method with a pitch that is less than the pitch of the network of probes, for example with an angular pitch which is a fraction of the pitch of the network of probes.

The tilting means are, for example, advantageously chosen to angularly sweep at least all of the angular pitch between two probes.

In the example illustrated in figure 1, these means include an electric motor 25 which drives an actuator (26).

This actuator extends more or less horizontally in the plane of the arc, and is hinged to one end of the base. The movement of this actuator is used to tilt the mast 20, conferring upon it a more or less pivoting movement that is centred on the centre 40 of the arc.

To allow this tilting motion, the base of the mast 20 is equipped with a convex bottom surface 21, which rests, by means of one or more rollers 22, on a complementary concave surface (not shown) on which it runs when the actuator is operated.

The complementary concave and convex shapes are chosen to allow the desired tilting/pivoting movement.

Another mode of implementation is illustrated in figure 2.

In this mode of implementation, the mast 20 is mounted to rotate around its axis, while the arc 10 is mounted on rollers 50 that allow it to pivot on itself, in its plane, around the centre 40.

An electric motor drive 60 is provided for this purpose in order to move the arc on itself with an angular motion of at least one angular pitch.

This motor drive 60 allows movement in either direction of course.

It will be seen that in one or other of the two variants which have just been described, the object under test can itself be moved in translation perpendicularly to the plane of the network of probes so as to allow field measurement in cylindrical coordinates.

Means can be provided specifically at the level of the support in order to guide the object under test in a movement perpendicular to the plane of the network.

Of course the devices are then used with no rotation around the A axis.

For each relative position of the network of probes and the object under test, acquisitions are effected in several relative tilting positions of the network of probes in relation to the object under test.

One thus gets a measurement result corresponding to a multiplication of the number of points measured.

The structure proposed by the invention also results in a greater number of measuring points in relation to the network of probes used, and as a consequence, in larger dimensions for the object to be measured or in larger ranges of measurement frequencies or wavelengths.